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Research Article

A new *Psammitis* species (Araneae, Thomisidae) from an extinct volcano in Georgia with reevaluation of the generic position of *Xysticus marmoratus* Thorell, 1875

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Abstract

A new species, *Psammitis abuliensis* **sp. nov**., from Didi Abuli Mt. (Georgia, Samtskhe-Javakheti region), is described based on two male specimens. Diagnostic drawings, measurements, collecting data, diagnosis, and DNA barcodes are given. A new combination, *Psammitis marmoratus* (Thorell, 1875), **comb. nov.** (ex. *Xysticus*), is proposed based on the COI subunit barcode results and morphological characters.

Key words: Arachnida, Caucasus, crab spider, description, diagnosis, new taxa, Samtskhe-Javakheti

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Introduction

The long and complicated taxonomic history of *Psammitis* Menge, 1876, involves its separation from *Xysticus* C.L. Koch, 1835, and recognition as an independent genera (Menge 1876; Dalmas 1922; Ono 1978; Wunderlich 1987; Lehtinen 2002; Breitling 2019), alternatively with synonymizations with *Xysticus* (Simon 1895; Ono 1988). To date, 32 taxa (30 species and 2 subspecies) of *Psammitis* are known, mostly distributed in the Palaearctic Region (WSC 2023), characterized by different diameters of lateral eyes and palp with anapophysate disc-shaped flat tegulum at best having simple folds or sclerotized ridges. From the seven species reported from the Western Palaearctic (Nentwig et al. 2023), only two congeners – *P. ninnii* (Thorell, 1872) and *P. sabulosus* (Hahn, 1832) – are recorded in the Caucasus and Georgia (Otto 2023; WSC 2023).

In September 2018, two male specimens of an unknown *Psammitis* species were sampled by the second author on Didi Abuli Mt. – an extinct volcano and the highest peak in the Lesser Caucasus in Georgia, located in the Abul-Samsari Range. Herein the specimens are described as *Psammitis abuliensis* sp. nov., accompanied by photos of the holotype, paratype, and *terra typica*, diagnostic drawings, collecting details, diagnosis, barcoding results, and a discussion on the generic placement of *Xysticus marmoratus* Thorell, 1875, based on the phylogenetic analysis.

Materials and methods

The material for the present study was collected on September 12, 2018, during fieldwork in Javakheti Highland, at the peak of the mountain Didi Abuli, by hand under small stones. The collected material was preserved in 96% ethanol and stored in a freezer under -22˚C at the scientific collections of Ilia State University (ISU), Georgia, Tbilisi, for further DNA barcoding. Photos of the preserved specimens (Figs 1–3) were taken using a Canon EOS 60D camera with a Canon EF-S 60mm f/2.8 Macro USM and Raynox DCR-250 Super Macro Snap-On Lens and a Canon Macro Twin Lite MT-26EX-RT attached, and the whole set was mounted on a Novoflex Castel-L Focusing Rack. Digital images were prepared using Zerene Stacker image stacking software and Adobe Photoshop CS6 (version 13.0). Diagnostic drawings were made based on microscope photographs using a Wacom CTH-690 Intuos Medium Pen and Touch Tablet with the programs Krita (version 2.9.7) and Photoshop CS6 (version 13.0). All measurements are given in mm.

The following abbreviations are used in the text, tables, and figures: ALE (anterior lateral eyes), AME (anterior median eyes), d (dorsal), Et (embolus tip), Fe (femur), Mt (metatarsus), Pa (patella), p (prolateral), PLE (posterior lateral eyes), PME (posterior median eyes), r (retrolateral), Ta (tarsus), Ti (tibia), TuA (tutacular apophysis), v (ventral). Leg spination system according to Ono (1988). The prolateral femoral spines of leg I and ventral metatarsal spines of leg II are not paired, thus the number is indicated.

DNA processing

DNA extraction at the ZFMK (Zoological Research Museum Alexander Koenig) followed the standard protocols of the GBOL (German Barcode of Life) project (Geiger et al. 2016; http://www.bolgermany.de). DNA extraction at ISU was performed following the implemented protocol (Seropian et al. 2023a). Extracted DNA was deposited in the scientific collections of Ilia State University, Tbilisi, Georgia, and aliquots will be deposited at The Leibniz Institute for the Analysis of Biodiversity Change (LIB) Biobank at Museum Koenig, Bonn, Germany, while the sequences have been submitted to Barcode of Life Data System (BOLD) databases (http://www.boldsystems.org/index.php). The newly obtained DNA barcodes of COI sequences were checked against the BOLD Systems database. The Barcode Index Numbers (BIN) (Ratnasingham and Hebert 2013) for the sequenced taxa and their nearest neighbor in BOLD Systems (if they had a BIN) are also given. For the calculation of sequence differentiation, we used p-distance as performed in the BOLD Systems.

In addition to the newly generated DNA barcodes, the published COI subunit barcodes of *Psammitis* spp. deposited in BOLD Systems and NCBI GenBank, along with a single barcode of *P. ninnii* originating from Georgia (obtained from the specimen collected within the CaBOL project), were included to evaluate relationships between *Psammitis* spp. based on uncorrected *p*-distance. As outgroups, COI barcodes obtained from the locally collected *Xysticus* spp., *Spiracme* spp., and *Bassaniodes* spp. were used (Table 1).

A Neighbor-Joining tree based on pairwise distances with 1000 bootstrap replicates was constructed with MEGA 11 software (Tamura et al. 2021) to visualize the phylogenetic relationships among specimens (Fig. 8).

Table 1. List of the COI sequences used for molecular analyses.

Species	Country of origin	CaBOL-ID number	BOLD/GenBank Acc. N.
***Psammitis abuliensis* sp. nov.**	Georgia	1012780	BOLD:AFP6894
***Psammitis abuliensis* sp. nov.**	Georgia	1012781	BOLD:AFP6894
Psammitis ninnii	Georgia	1012634	BOLD:ACU8868
Spiracme striatipes	Georgia	1023862	BOLD:AAD6911
Xysticus acerbus	Georgia	1010349	BOLD:AAG1214
Xysticus marmoratus	Georgia	1016820	BOLD:AAF8321
*Bassaniodes pseudorectilineus**	Georgia	1010063	BOLD:AAO1746
Psammitis deichmanni	Canada		BOLD:AAB7094
Psammitis labradorensis	Canada		BOLD:AAB1154
Psammitis rugosus	Canada		BOLD:AEO1986
Psammitis sabulosus	Norway		BOLD:ABU5838
Psammitis sabulosus	Germany		BOLD:ABU5838
Psammitis ninnii	Spain		MW998589.1

* The first record in Georgia, which will be featured in an upcoming article.

Results

Family Thomisidae Sundevall, 1833

Genus *Psammitis* Menge, 1876

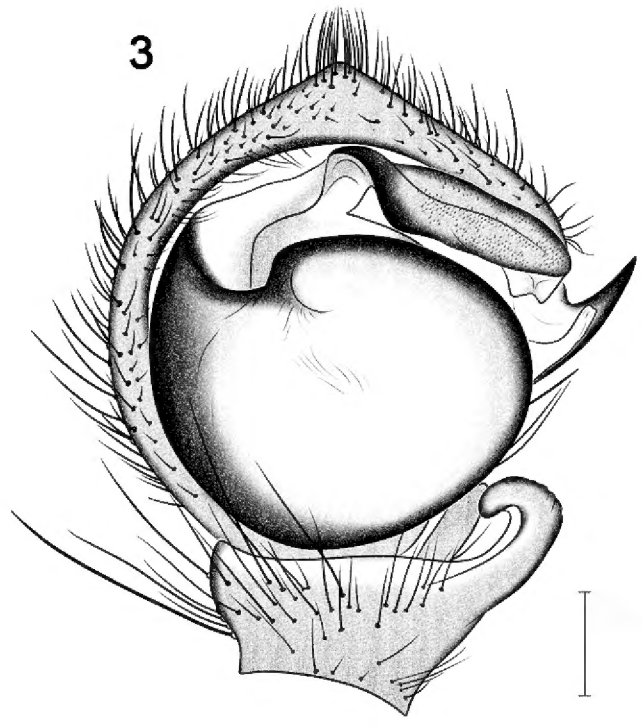
Type species. *Thomisus sabulosus* Hahn, 1832

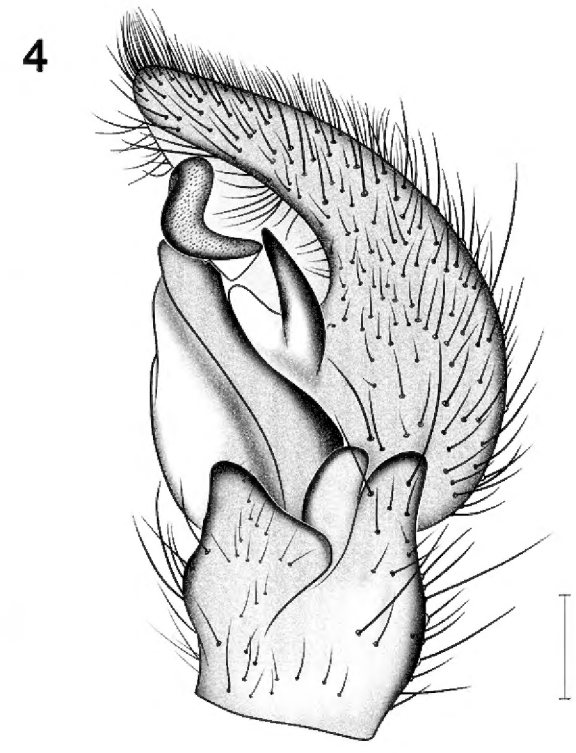
***Psammitis abuliensis* sp. nov.**
Figs 1–5
https://zoobank.org/325DC4FB-4400-4DE1-8803-B7F0DA12527B

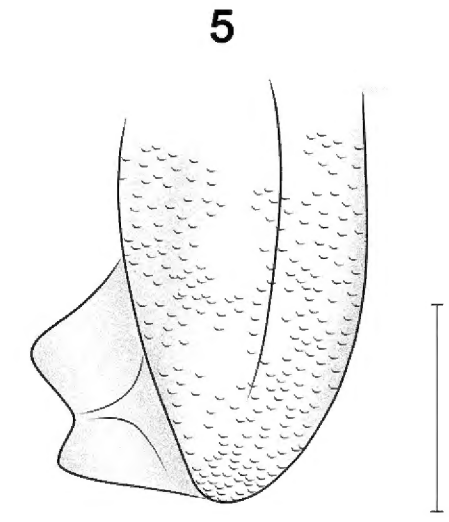
Type material. Holotype: ♂ (CaBOL-ID 1012781): Georgia: Samtskhe-Javakheti, Akhalkalaki municipality, Didi Abuli Mt.; N41.4380°, E43.6462°; 3267 m a.s.l., under rocks; 12 September 2018; leg. L. Mumladze. Paratype: 1♂ (CaBOL-ID 1012780): same collecting data. Both specimens are deposited in the scientific collections of Ilia State University, Georgia, Tbilisi.

Diagnosis. The new species resembles *P. sabulosus* (Hahn, 1832) that occurs in Georgia (Thaler 1981: figs 52, 57; Jantscher 2002: figs 5–6) and *P. demirsoyi* (Demir, Topçu & Türkes, 2006) from Turkey (Demir et al. 2006: figs 1–2, 5–7). The males of the new species can be distinguished from those of *P. sabulosus* by having a bow tie-shaped very short and broad embolus tip (vs. long and thin), a longer basal embolus, and a larger tutacular apophysis. From the males of *P. demirsoyi*, those of *P. abuliensis* sp. n. can be distinguished by the presence of a large tutacular apophysis (vs. absence) and a bow tie-shaped very short and broad embolus tip (vs. differently shaped longer and thinner) (Figs 3, 5).

Description. Male (holotype/paratype). Total length: 6.90/6.85; Carapace: 3.41/3.39 long, 3.35/3.35 wide; Abdomen: 3.80/3.85 long, 3.30/3.32 wide; Clypeal height: 0.35/0.34; Clypeus with 15 long and robust bristles; Chelicer-al length: 1.15/1.15; AME: 0.11/0.11; ALE: 0.20/0.20; PME: 0.11/0.11; PLE: 0.14/0.14. Color and pattern as shown in Figs 4–5. Sternum yellow, with irreg-







Figures 1–5. *Psammitis abuliensis* **sp. nov.**, male (**1** holotype, dorsal habitus **2** paratype, dorsal habitus **3** left palp, ventral view **4** ditto, retrolateral view **5** tip of embolus, rotated). Scale bars: 2 mm (1–2); 0.2 mm (3–4); 0.1 mm (5).

ular dark spots. Leg coloration: Fe and Pa I–IV dark brown (Fe and Pa III–IV apically lightened), Ti, Mt, and Ta I–IV dark yellow (Ti I–II basally darkened). Leg measurements and spination as in Tables 2 and 3.

Female unknown.

Etymology. The specific epithet is an adjective referring to the type locality of the new species in Akhalkalaki municipality.

Habitat. Two males of the new species were obtained by hand collecting under the small stones on a mountaintop (Figs 6–7).

Distribution. Known from the type locality only.

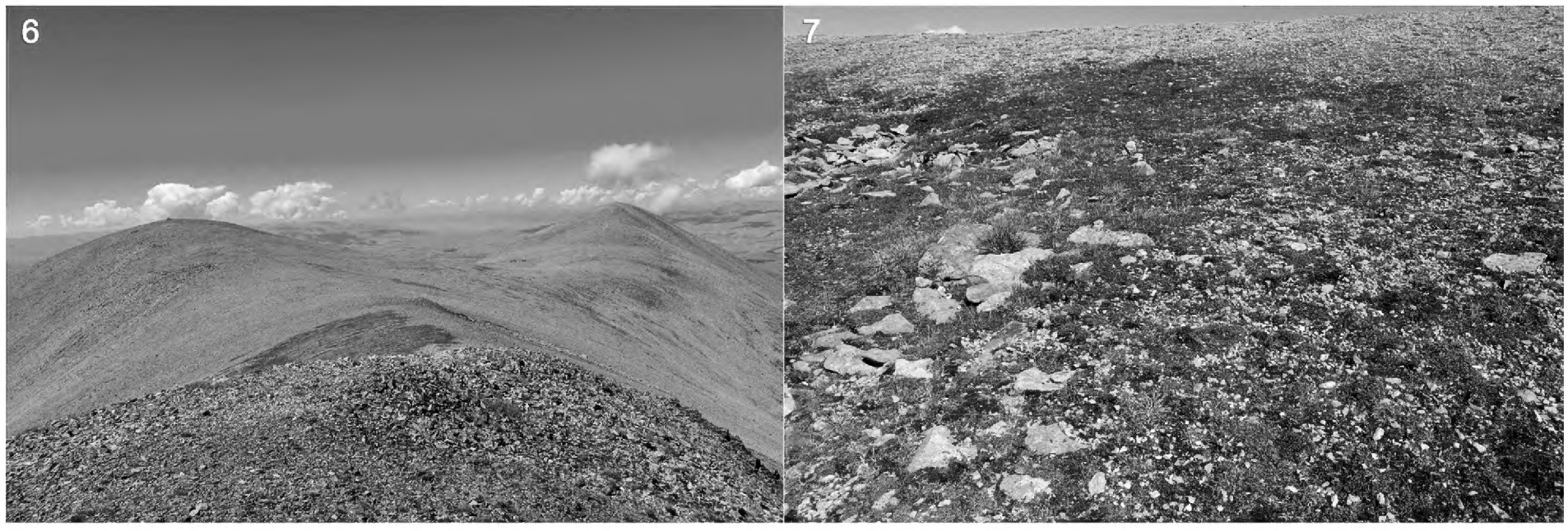
Barcoding results. Two identical barcodes were obtained from the specimens with CaBOL-IDs 1012780 and 1012781 (BOLD:AFP6894) with the nearest neighbor in the BOLD Systems *P. ninnii* from Spain with a private status (*p*-distance 6.3%).

Table 2. Length (mm) of leg segments. Male (holotype/paratype).

	Fe	Pa	Ti	Mt	Ta	Total
I	3.51/3.51	1.42/1.41	2.60/2.58	2.50/2.50	1.21/1.20	11.24/11.20
II	3.31/3.30	1.52/1.52	2.52/2.50	2.11/2.11	1.21/1.21	10.67/10.64
III	1.55/1.53	1.11/1.11	2.04/2.02	1.72/1.71	1.04/1.04	7.46/7.41
IV	2.25/2.22	1.02/0.98	2.11/2.09	1.80/1.80	1.02/1.02	8.20/8.11

Table 3. Leg spination.

	Fe	Ti	Mt
I	d0-1-1-1-1 p11	p1-1-1 r1-1-1	p1-1-1-1-1ap r1-1-1-2ap
		v2-1-2-2-2-1-2ap	v1-1-2-1-1-1ap
II	d1-1-2-1-1	p1-1-1 r1-1-1	p1-1-1-1ap r1-1-1ap
		v2-1-1-1-1-1-1-2ap	v11-2ap
III	d0-1-1-1-1-1	p1-1-1ap r1-1-0	p1-1-1ap r1-1-1ap
		v1-1-1-1-1-1	v2-2-2
IV	d1-1-1	p1-1 r1-1 -1	p1-1-1ap r1-1-1ap
		v1-1-1-1-2ap	v1-1-1-1-2ap



Figures 6–7. Type locality of *Psammitis abuliensis* sp. nov. in Georgia, Didi Abuli Mt. (6 – sampling area; 7 – sampling plot).

***Psammitis marmoratus* (Thorell, 1875), comb. nov.**

Xysticus marmoratus Mcheidze, 1997: 163, figs 305–306 (♂).
Xysticus embriki Hepner et al., 2011: 38, figs 5–10 (♂♀).

Note. For full nomenclatural references see WSC (2023).

Comments. This species is transferred to this genus due to the similarity of the male palp to the generotype, which possesses an anapophysate tegulum. As for the *Psammitis* spp. females, there seem to be no defined characters allowing reliable separation from *Xysticus* spp. The generic reevaluation is also supported by the phylogenetic tree generated within the preset study, which includes *Xysticus marmoratus*, a species not involved in a subset of the analyses performed by Breitling (2019), who supported the recognition of *Psammitis* as an independent genus. Our results suggest a close relationship between *X. marmoratus* and *Psammitis* spp. (Fig. 8); therefore, we propose a new combination, *Psammitis marmoratus* (Thorell, 1875), comb. nov. (= *Xysticus marmoratus* Thorell, 1875).

Discussion

Recent studies and collecting efforts in Georgia within the last half a decade have resulted in an additional 5 species of Thomisidae, of which one species is new to science (the herein-described *Psammitis abuliensis* sp. nov.) (Seropian

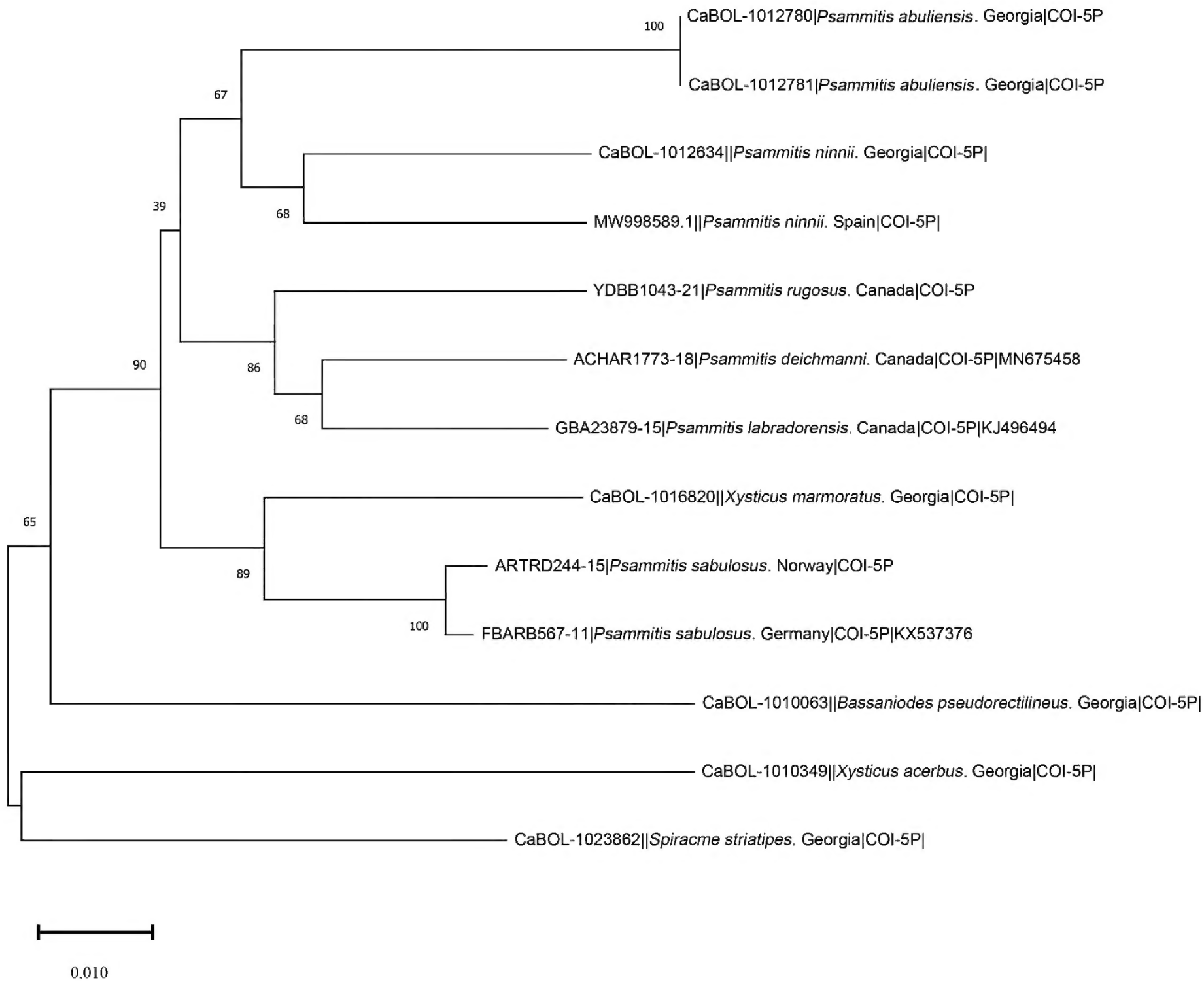


Figure 8. Phylogenetic relationships are presented by the Neighbor-Joining tree based on the mitochondrial COI barcode using the *p*-distance model with other default parameters provided by Mega 11. The analyses involved 13 COI nucleotide sequences of 10 thomisid species. Numbers indicate bootstrap support values from 1000 replicates.

et al. 2023a, b; present article). The herein reevaluation of *P. marmoratus* (ex. *Xysticus*) and the result of the research conducted by Breitling (2019) suggest a strong need for further revision of *Xysticus* spp. The exploration of remote, poorly studied, and hard-to-reach localities in Georgia could result in findings of more new species and redescriptions of very poorly defined three species endemic to the Caucasus region, namely *X. caucasius* L. Koch, 1878, *X. charitonowi* Mcheidze, 1971, and *X. kalandadzei* Mcheidze & Utotschkin, 1971, described by single females and known from single publication(s).

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

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Author contributions

AS made a morphological description of the specimens and wrote the first draft of the manuscript. LM Collected material and revised the final version of the manuscript.

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Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.

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